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A PUBLICATION OF THE WORLD REPORTING SERVICE ON PLANT DISEASES AND PESTS

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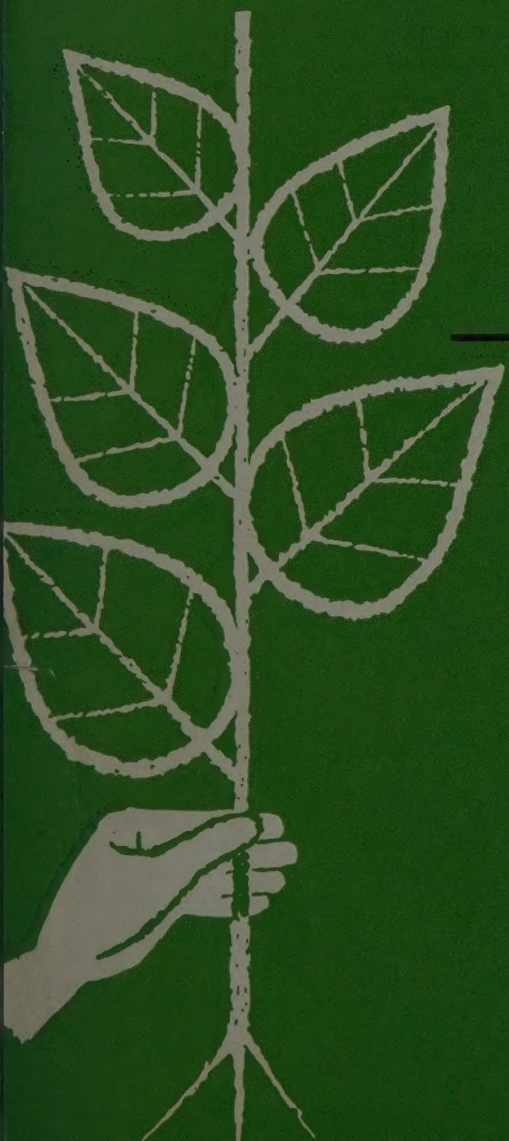

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FAO PLANT PROTECTION BULLETIN

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FAO PLANT PROTECTION BULLETIN

A PUBLICATION OF THE WORLD REPORTING SERVICE ON PLANT DISEASES AND PESTS

Identification of Aphids Living on *Citrus*

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Recent developments in the study of tristeza and allied diseases of *Citrus* in the Mediterranean Basin have made it desirable to provide field workers with a means of identifying collections of aphids made from *Citrus* species. To meet this requirement, in February 1960 the European and Mediterranean Plant Protection Organisation asked for a series of black-and-white drawings illustrating the taxonomic characters of the aphids living on *Citrus*. Through the kindness and co-operation of the Director and staff of the British Museum (Natural History) these drawings were made by the Museum's artist, Mr. Arthur Smith. It has been felt that their usefulness can be increased by the addition of a short, written account aimed at providing a self-contained source of information for field entomologists and others who may, in the future, be charged with the surveying of *Citrus* for aphid vectors of virus diseases.

I wish to acknowledge most gratefully the help received from Mr. J.P. Doncaster and Dr. V.F.Eastop of the British Museum (Natural History) in the preparation of the text, by the checking of keys against material in the Museum collection, co-ordination of text indications with drawings, and suggestions for amendments or additions to the text and bibliography. Any acknowledgment of Mr. Arthur Smith's services here would be presumptuous, inasmuch as his drawings (Figures 1 to 12) represent by far the more important part of the work, to which the text is merely an appendage.

Collection and preservation of aphid material

The foliage of *Citrus* is, in general, only suitable for the nutrition of aphids during its pale green juvenile phase. The surveying of a grove for aphids is therefore most economically achieved by inspection of the young growth; and during those parts of the year when growth is at a minimum it is virtually only on such few young shoots as may be found, e.g., springing from the trunk or near graft unions, that the aphid population can maintain itself. Since none of the known species on *Citrus* appears capable of laying resistant eggs there, this means that the yearly cycle of abundance shows very marked extremes. At times when aphids are very scarce it may be of value to inspect the undersides of mature foliage for dead, parasitized aphids or "mummies," since these adhere tenaciously to the leaves after death and can be used for identification in the absence of living specimens. When a shoot is, or has been, attacked by aphids there will usually be a certain amount of deformation of the leaf lamina by twisting or rolling, and this may persist in the mature foliage and indicate where such a search for mummies may be profitable.

Aphid material for identification should be preserved in a fluid consisting of 2 volumes of 95 percent ethanol to 1 volume of 75 percent (weight for weight) lactic acid. Samples collected in the field should ideally be taken back to the laboratory alive in small tubes or tins plugged with wadding and including a small

piece of juvenile shoot. It may then frequently be possible to breed out winged specimens within a day or two from a sample that, when collected, contains only immature forms and wingless adults. Apart from this, the making of accurate color notes is also much easier if done at leisure in the laboratory. Data for each sample should be kept separately in a field notebook, and each container should have a label recording its identity and referring to the notebook.

Preparation for identification

While an experienced entomologist can identify most *Citrus* aphids by inspection with a pocket lens in the field, until such facility is attained it is necessary to examine specimens prepared as microscopic objects. Such preparations may be permanent, if the aphids are mounted in a medium such as Faure's mountant or "Celodal," or temporary, if mountants such as glycerine jelly or polyvinyl alcohol-lactophenol are used. The essential for all preparations, whether temporary or permanent, is adequate clearing, to enable details of cuticular sculpture, pigmentation and chaetotaxy to be examined. The following procedure is recommended :

1. boil aphids gently in 95 percent ethanol *on a waterbath* for about 5 minutes ;
2. transfer aphids to 10 percent potassium hydroxide solution and simmer gently over a very small flame for 1 to 2 minutes;
3. add an equal volume of 95 percent ethanol and mix with a pipette; when aphids sink, decant fluid;
4. rinse aphids in 95 percent ethanol;
5. transfer to clearing fluid composed of equal parts by weight of anhydrous phenol and chloral hydrate crystals melted together; warm in this mixture for 10 minutes;
6. mount aphids in glycerine jelly or PVA-lactophenol.

If permanent mounts are required, a modified Faure's medium is recommended. The formula for this is as follows :

Gum arabic (picked lumps).	12 gm.
Chloral hydrate (crystals).	20 gm.
Glacial acetic acid	5 ml.
Glucose syrup (50 percent w/w)	5 ml.
Distilled water	40 ml.

The constituents are dissolved in the water in the order shown, using only slight warmth overnight to dissolve the gum. When prepared, the mixture is filtered over glass wool and evaporated to the desired consistency at not more than 30° C. When using this formula for the mountant it is necessary also to add an equivalent amount of glucose syrup to the phenol-chloral hydrate clearing fluid to maintain hypertonicity of the aphids' appendages on transfer to the mountant, otherwise collapse of the former may take place. Permanent mounts using this formula are baked in an oven at about 35° C. for 2 to 3 days to harden the peripheral gum and fix the cover slips. They can then be sent by post without any danger if steps are taken to keep the packing away from contact with the cover slips.

Identification of species

Seven widely-distributed species of aphids, all belonging to the family Aphididae (in the sense of Börner [2] and Börner and Heinze [3]) occur more or less commonly on cultivated *Citrus*. Of these, all save one live commonly also on a greater or smaller number of other hosts not belonging to the plant family Rutaceae, and these hosts can therefore act as reservoirs of population at the times of year when aphids are scarce on *Citrus*. The seventh species, *Toxoptera citricidus* (Kirkaldy), besides being less polyphagous, and only occurring rarely and probably casually on plants other than Rutaceae, is also the most efficient known aphid vector of tristeza virus.

The seven species to be discussed here are :

Macrosiphum euphorbiae (Thomas)
Myzus (*Nectarosiphon*) *persicae* (Sulzer)
Aphis gossypii Glover
Aphis spiraecola Patch
Aphis craccivora Koch
Toxoptera aurantii (Boyer de Fonscolombe)
Toxoptera citricidus (Kirkaldy)

The following key is designed to enable both alate (winged) and apterous (wingless) viviparous females to be identified. It should be used in conjunction with the detailed drawings of the various species, to which references are given in the couplets of the key. The scale indicators in Figures 1 to 12 represent a length of 0.1 mm. Figure 13 is a diagram of the posterior segments of the abdomen of an apterous viviparous female of the genus *Aphis* L. It represents an imaginary species with ideally disposed characters and should not be expected to agree in detail with any of the species described here.

Key to viviparae of *Citrus* aphids

1. (4) Front of head markedly excavated or excised in the middle when seen from above, i.e., lateral prominences much more produced than median prominence (if present) (see Figures 1 Mp; 2 Me). Green or pinkish-red aphids with siphunculi pale or only gradually darkened to apex, or with an inconspicuous dark tip. Seventh abdominal segment without marginal tubercles (see Figure 11 Mp).

2. (3) Frontal excision in *apterae* distinctly angulated or W-shaped, and head roughened by many small nodules or spinules visible in cleared specimens (see Figure 1 Mp). *Alatae* with abdominal dorsum largely occupied centrally by a solid dark patch, with lateral extensions on the discal segments, and with usually a small transverse oval weakening or fenestra posteriorly between the siphunculi (cornicles) (see Figure 11 Mp). Antennae in *apterae* without secondary rhinaria (see Figure 5 Mp). Siphunculi very slightly thickened over apical half, blackish-tipped; apex without reticulate sculpturing (see Figure 7 Mp). *Apterae* in life dull pale to mid-green, rather shagreened under high magnification. *Alatoid nymphs* brownish pink with darker longitudinal lines. *Alatae* with thoracic capsule black or blackish.

Myzus persicae (Sulzer)

3. (2) Frontal excavation not angulated in *apterae*, rather smoothly curved and head not roughened with nodules or spinules (see Figure 2 Me). *Alatae* without any central dark markings on abdominal dorsum. Antennae in apterae with some secondary rhinaria present toward base of III. Siphunculi gently tapering from base to apex (sometimes barely perceptibly thickened on apical 1/4), apical 1/9 to 1/5 with a well-marked reticulate pattern visible in cleared specimens (see Figure 2 Me); pale over whole length, or gradually darkening over apical half. Color in life rather velvety yellow-green (adults) or greyish green from the presence of wax powder (immature specimens). *Alatae* with thoracic capsule brown. All morphs may occasionally be pinkish in color instead of green.

Macrosiphum euphorbiae (Thomas)

4. (1) Front of head not markedly excavated or excised when seen from above, at most somewhat sinuate, with the central prominence as high or almost as high as the lateral ones (see Figure 1 Ag, Tc). Head not spinulose or nodulose. Green, yellow, brown or blackish (never pinkish) aphids, with uniformly dark siphunculi. Seventh abdominal segment with a pair of marginal tubercles (see Figures 4; 10; 11 Ac).

5. (8) Abdomen latero-ventrally at and behind siphunculi with an area of very marked and characteristic sculpturing in the form of serrate ridges which are more or less sclerotized on the serrations (see Figure 2 Ta, Tc). Correlated with this, the hind tibiae bear dorsally a row of hairs modified into very short, stout conical spines (see Figures 8 Ta, Tc; 9 Ta, Tc); the two structures together forming a stridulatory organ which in one species of the genus produces a sound audible to the human ear. Color: shiny brownish-black when adult, paler brown when immature. Caudal hairs

Figures in parentheses refer to literature cited at the end of the article.

8 to 54 in number, but rarely less than 12 (see Figures 3 Ta, Tc ; 4).

Genus *Toxoptera* Koch

6. (7) *Alatae*: antenna with segment III entirely blackish, with 6 to 20 secondary rhinaria (usually 9 or more); segment IV with 0 to 4, most often with 0. Longest measurable hairs on segment III longer than the diameter of the segment at its basal articulation (see Figure 6 Tc). Marginal abdominal hairs very fine and long, maximally 0.06 to 0.08 mm. long, or longer than the diameter of the siphunculus at its apical operculum (see Figure 4 Tc). Crural hairs similar, those on the outer side of hind tibiae maximally 0.08 to 0.10 mm. long, or from about $^3/_4$ to subequal to length of joint II of hind tarsus measured without the claws (see Figure 8 Tc). Forewings with median nervure normally twice forked, and with rather pale and inconspicuous pterostigma (character best seen with a pocket lens) (see Figure 12 Tc). Siphunculi about $^1/_6$ of body length, more densely and strongly sculptured (see Figure 7 Tc). Cauda rather bulbously rounded apically, with 22 to 40 hairs (see Figure 3 Tc). *Apterae*: antennal hairs on segment III varying from about 29 to 64 μ in maximal length, or from about 1 $^1/_5$ to twice articular diameter of III, their apices varying from abrupt to very fine and indeterminate (see Figure 5 Tc). Hairs on abdominal margins and legs as in alatae (see Figure 4 Tc). Siphunculi as for alatae but relatively shorter (see Figure 7 Tc). Cauda thick, bluntly rounded at apex, with 19 to 54 hairs (see Figure 3 Tc). Size of body larger, up to 2.8 mm. long in apterae, 2.6 mm. in alatae.

Toxoptera citricidus (Kirkaldy)

7. (6) *Alatae*: antenna with segment III pale except for extreme apex, with 2 to 8 secondary rhinaria (usually 3 to 6); segment IV with 0, or quite exceptionally with 1 rhinarium (see Figure 6 Ta). Hairs on III nearly always maximally shorter than articular diameter of segment, their apices always distinct (see Figure 6 Ta). Marginal abdominal and crural hairs similar in structure, the former maximally 0.04 mm. or less, shorter than opercular diameter of siphunculi ; hind tibiae with outer hairs not more than 0.06 mm. long, or less than $^2/_3$ the length of joint II of hind tarsus measured without the claws (see Figure 8 Ta). Forewings with median nervure nearly always only once forked, and with a conspicuously dark pterostigma (best seen with a pocket lens. See Figure 12 Ta). Siphunculi about $^1/_7$ or less of body length, more sparsely and weakly sculptured (see Figure 7 Ta). Cauda more acute and not bulbously rounded at apex, with 8 to 16 hairs (see Figure 3 Ta).

Apterae : antennal hairs on segment III maximally from not much over half articular diameter of segment to subequal to this diameter, apices clearly visible and often abrupt ; absolute length maximally 16 to 27 μ (see Figure 5 Ta). Marginal abdominal and crural hairs as for alatae. Cauda somewhat tapering, more acutely rounded at apex, with 10 to 26 hairs (see Figure 3 Ta). Body smaller, not more than 2 mm. long in apterae or alatae.

Toxoptera aurantii (B. de Fonscolombe)

8. (5) Abdomen without a specialized stridulatory area ventrolateral to siphunculi. Hind tibiae without a row of conical spines in adults, all hairs being simple and unmodified. Caudal hairs: 4 to 14 in number, but if more than 8 then insect lemon yellow to apple green.

Genus *Aphis* Linnaeus

9. (10) Femoral hairs, at least in part, very finely produced apically, those on anterior and posterior aspects of about equal length, which is maximally nearly as long as to longer than the minimum thickness of the femur near the trochantro-femoral suture (see Figures 8 As; 9 As). Caudal hairs 7 to 14. (Color lemon yellow to apple green in life.) *Apterae* without sclerotic pigmentation of abdominal dorsum. *Alatae* without a median sclerite lying on abdominal tergite 6 between siphun-

cular bases, and with 0 to 5 secondary rhinaria on antennal segment IV.)
Aphis spiraecola Patch

10. (9) Femoral hairs of normal type, those on anterior aspect shorter than those on posterior aspect, and maximally not more than half to two thirds of least thickness of femur in length (see Figures 8 Ag, Ac; 9 Ag, Ac). *Alatae* without secondary rhinaria on antennal segment IV, and normally with a well-developed sclerite on the sixth abdominal tergite, between the siphuncular bases (see Figures 10 Ag; 11 Ac).

11. (12) *Apterae* with dorsal surface exhibiting a well-marked reticulation in cleared specimens, and with a greater or lesser number of the polygonal spaces of this filled up with dark pigmentation to form a more or less extensive area of mosaic-like blackish pattern; this area appears shining black under a pocket lens in life (see Figure 11 Ac). (*Alatae* without this pattern, but frequently with rather long dark segmental bars across the abdominal tergites.) *Alatae* with apical segment of rostrum from about $^{9}/_{10}$ as long to subequal to joint II of hind tarsus, measured without claws. (Color in life dark blackish to brownish green, adult apterae standing out among their progeny because of the shiny black abdominal dorsum.)
Aphis craccivora Koch

12. (11) *Apterae* without a marked reticulate pattern on dorsum after clearing, and without appreciable pigmented pattern on dorsum (see Figure 10 Ag); not shining when adult. *Alatae* with variable dorsal markings, but usually with at least small median sclerites from tergites 6 to 8 inclusive, and in larger specimens often with such sclerites on some anterior abdominal tergites as well (see Figure 10 Ag). Apical segment of rostrum from about $1\ ^{1}/_{10}$ to $1\ ^{1}/_{5}$ times as long as joint II of hind tarsus without claws. (Color in life extremely variable, most often some shade of greyish green or dark green, marbled with paler green, and often tinged with yellow; both adults and immature forms dull, not at all shiny.)
Aphis gossypii Glover

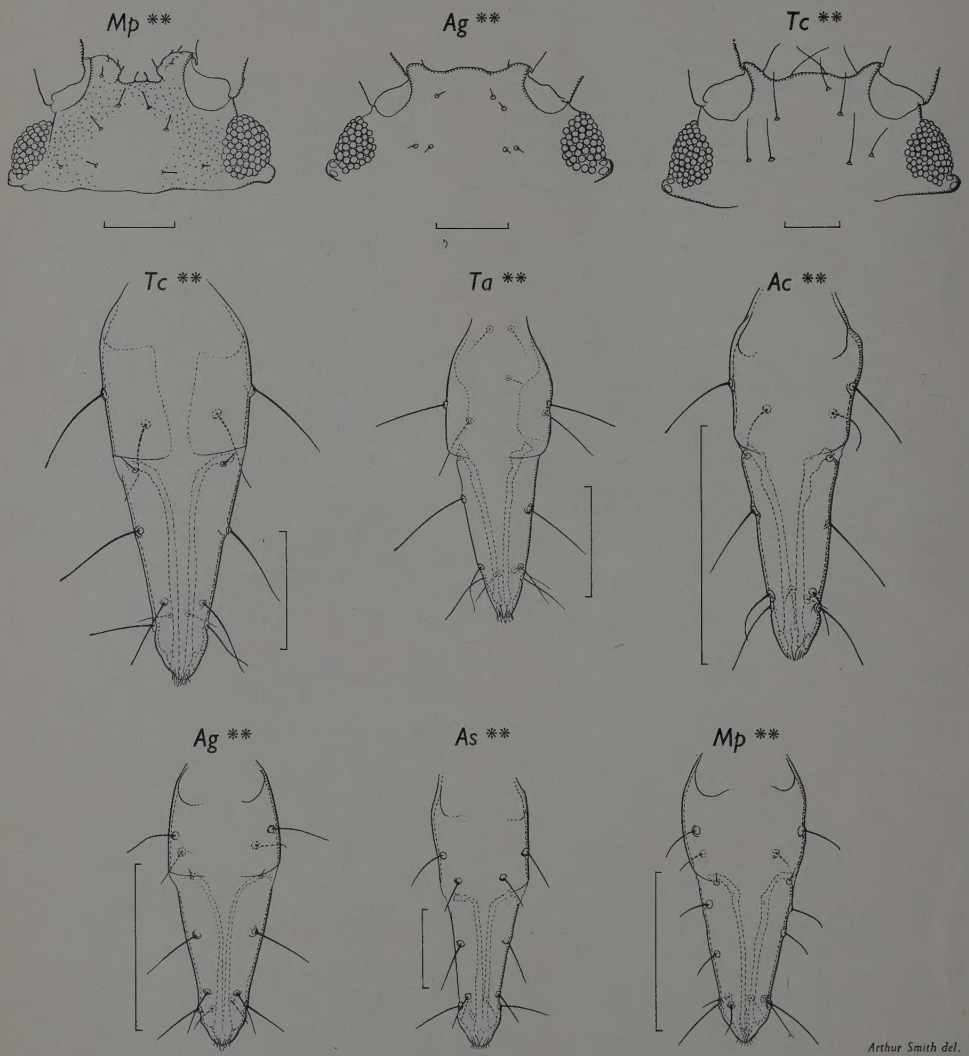
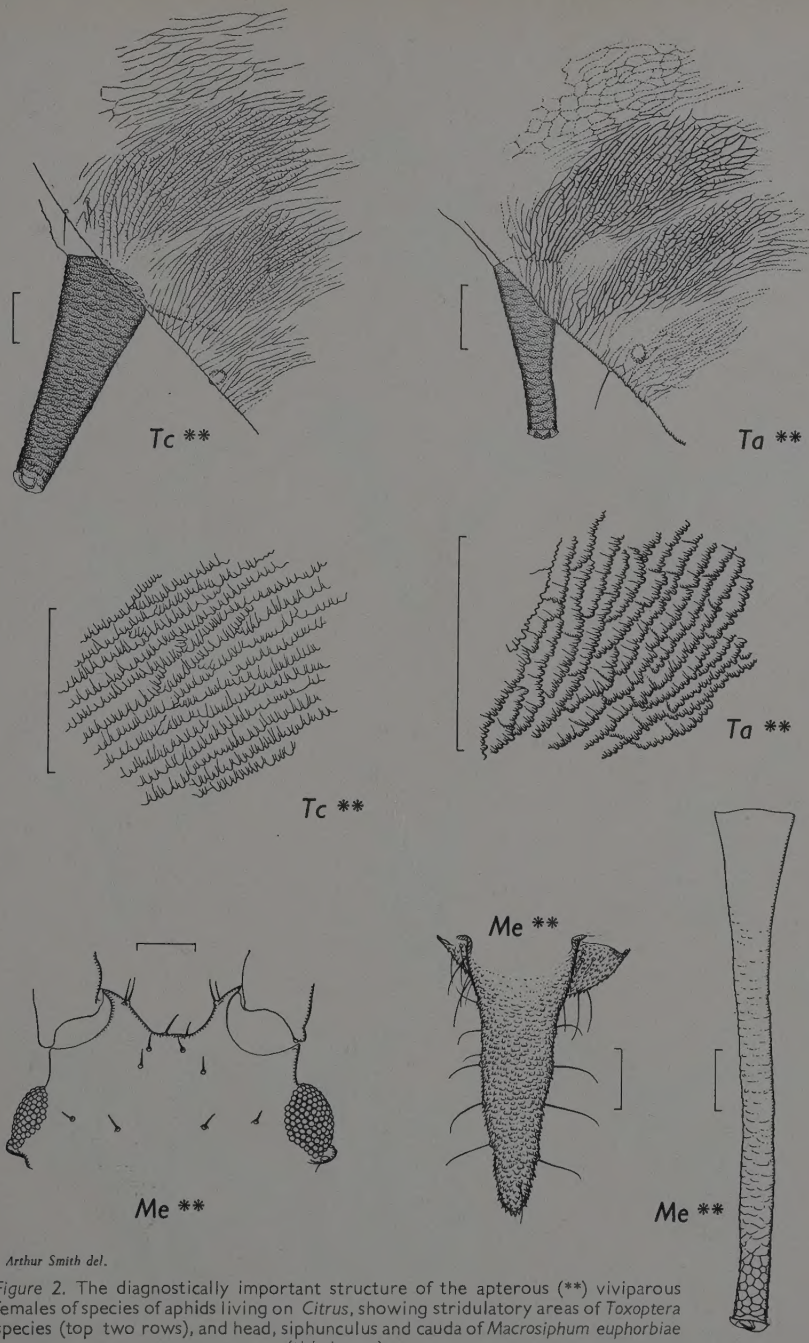


Figure 1. The diagnostically important structures of the apterous (**) viviparous females of species of aphids living on *Citrus*, showing heads (top row), and apical rostral segments (second and third rows). In Figs. 1 to 12 the following abbreviations are used : Ac *Aphis craccivora* Koch. Ag *Aphis gossypii* Glover. As *Aphis spiraecola* Patch. Me *Macrosiphum euphorbiae* (Thomas). Mp *Myzus persicae* (Sulzer). Ta *Toxoptera aurantii* (B. de Fonsc.). Tc *Toxoptera citricidus* (Kirkaldy).



Arthur Smith del.

Figure 2. The diagnostically important structure of the apterous (**) viviparous females of species of aphids living on *Citrus*, showing stridulatory areas of *Toxoptera* species (top two rows), and head, siphunculus and cauda of *Macrosiphum euphorbiae* (third row).

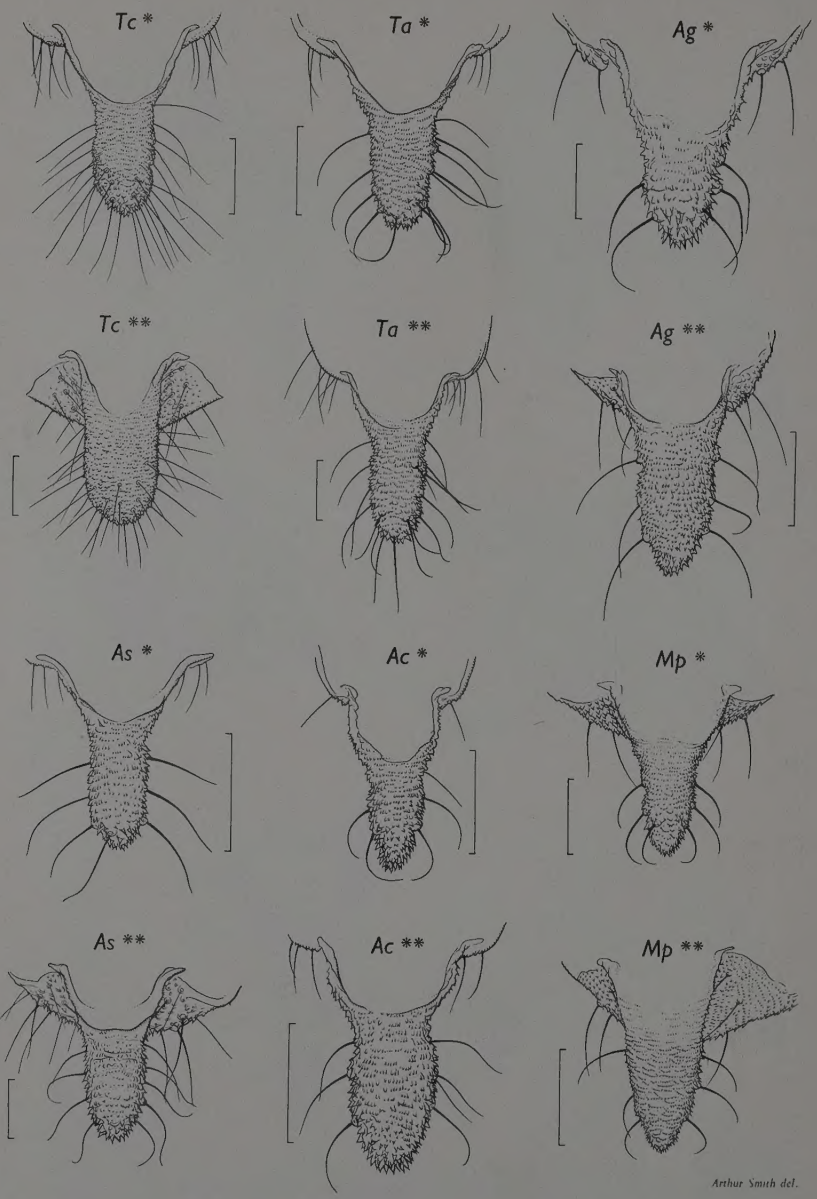


Figure 3. The diagnostically important structures of the alate (*) and apterous (**) viviparous females of species of aphids living on *Citrus*, showing caudæ.

Figure 4. The diagnostically important structures of the alate (*) and apterous (**) viviparous females of species of aphids living on *Citrus*, showing abdomina of *Toxoptera* species.

Figure 5. The diagnostically important structures of the apterous(**) viviparous females of species of aphids living on *Citrus*, showing antennae.

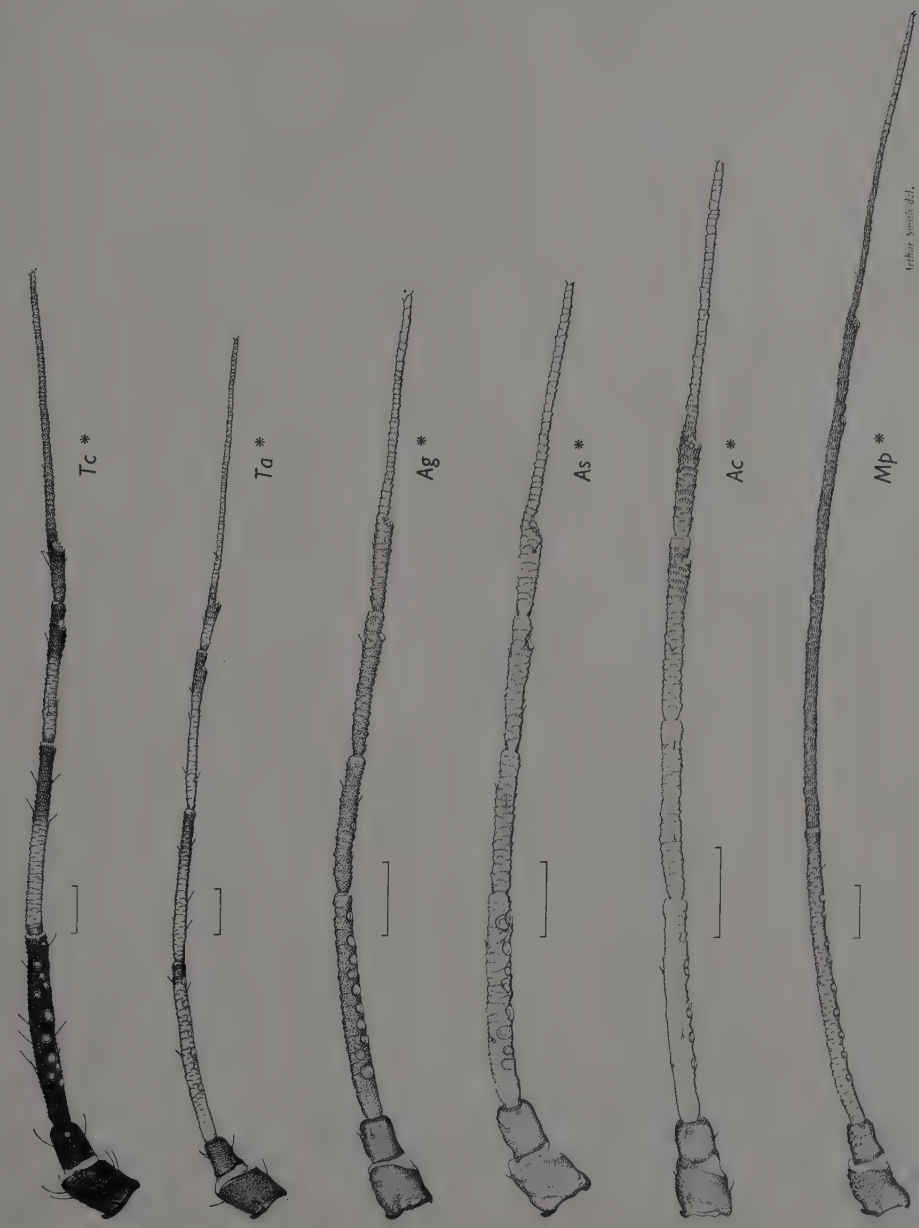


Figure 6. The diagnostically important structures of the alate (*) viviparous females of species of aphids living on *Citrus*, showing antennae.

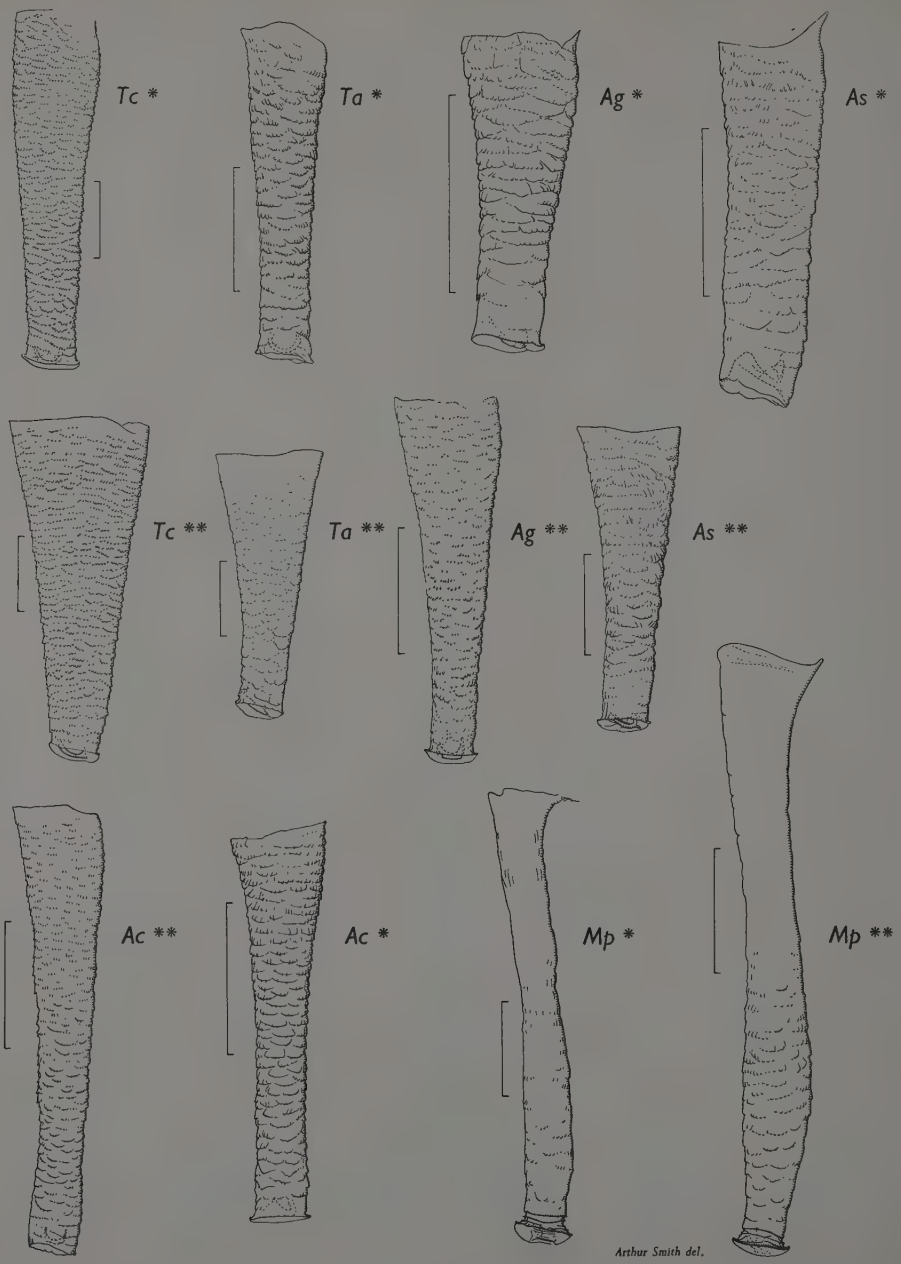


Figure 7. The diagnostically important structures of the alate (*) and apterous (**) viviparous females of species of aphids living on *Citrus*, showing siphunculi.

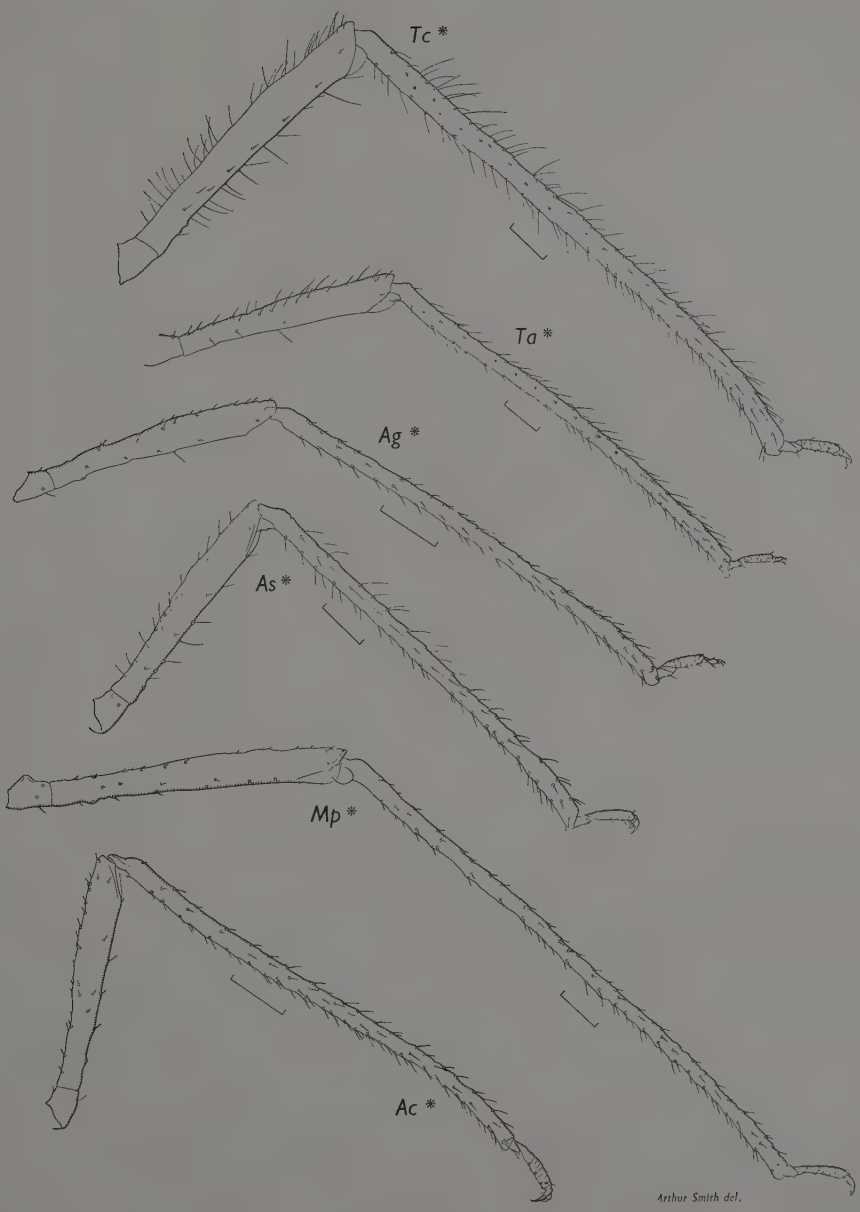


Figure 8. The diagnostically important structures of the alate (*) viviparous females of species of aphids living on *Citrus*, showing hind legs.

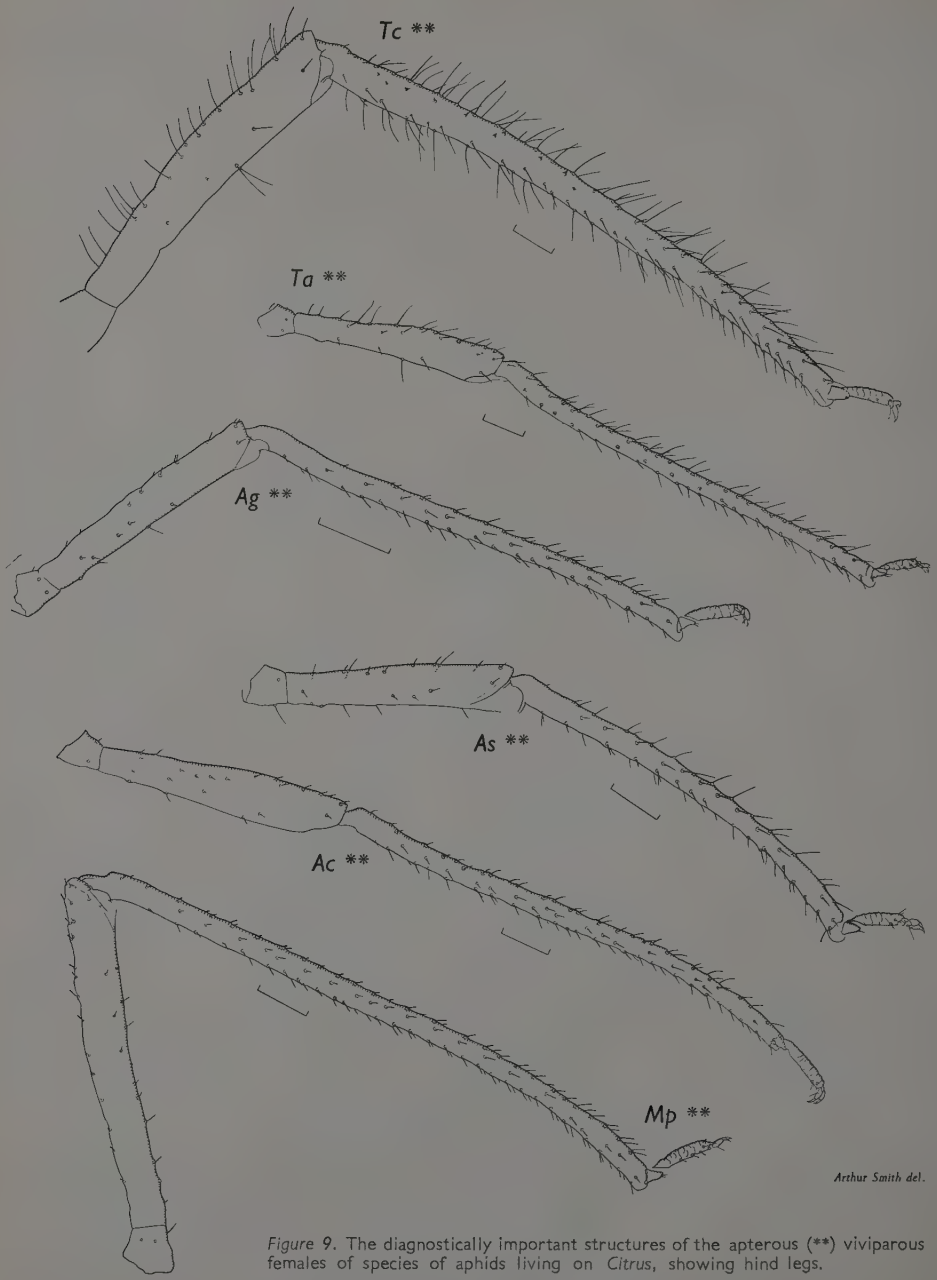


Figure 9. The diagnostically important structures of the apterous (**) viviparous females of species of aphids living on *Citrus*, showing hind legs.

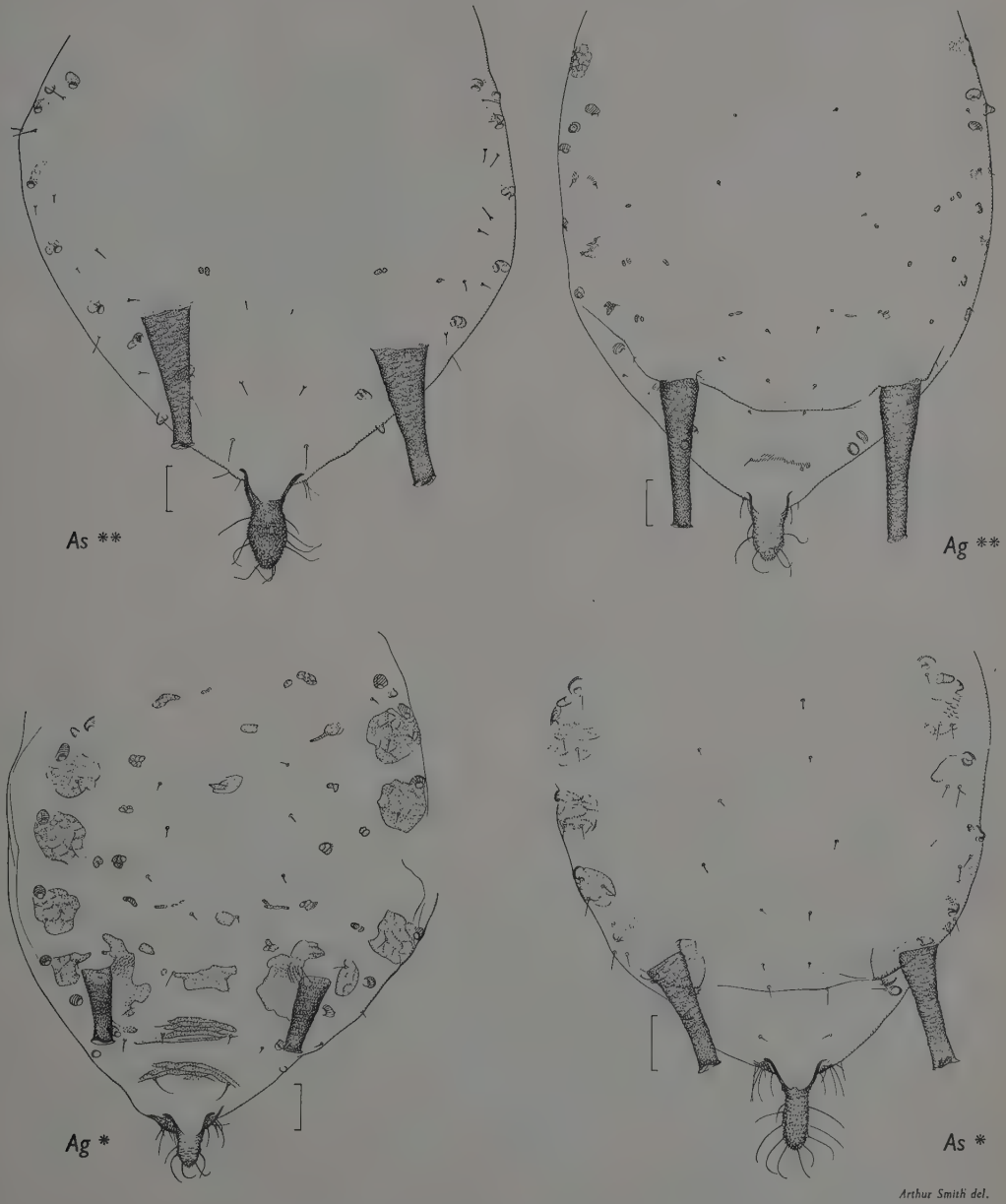


Figure 10. The diagnostically important structures of the alate (*) and apterous (**) viviparous females of species of aphids living on *Citrus*, showing abdomina.

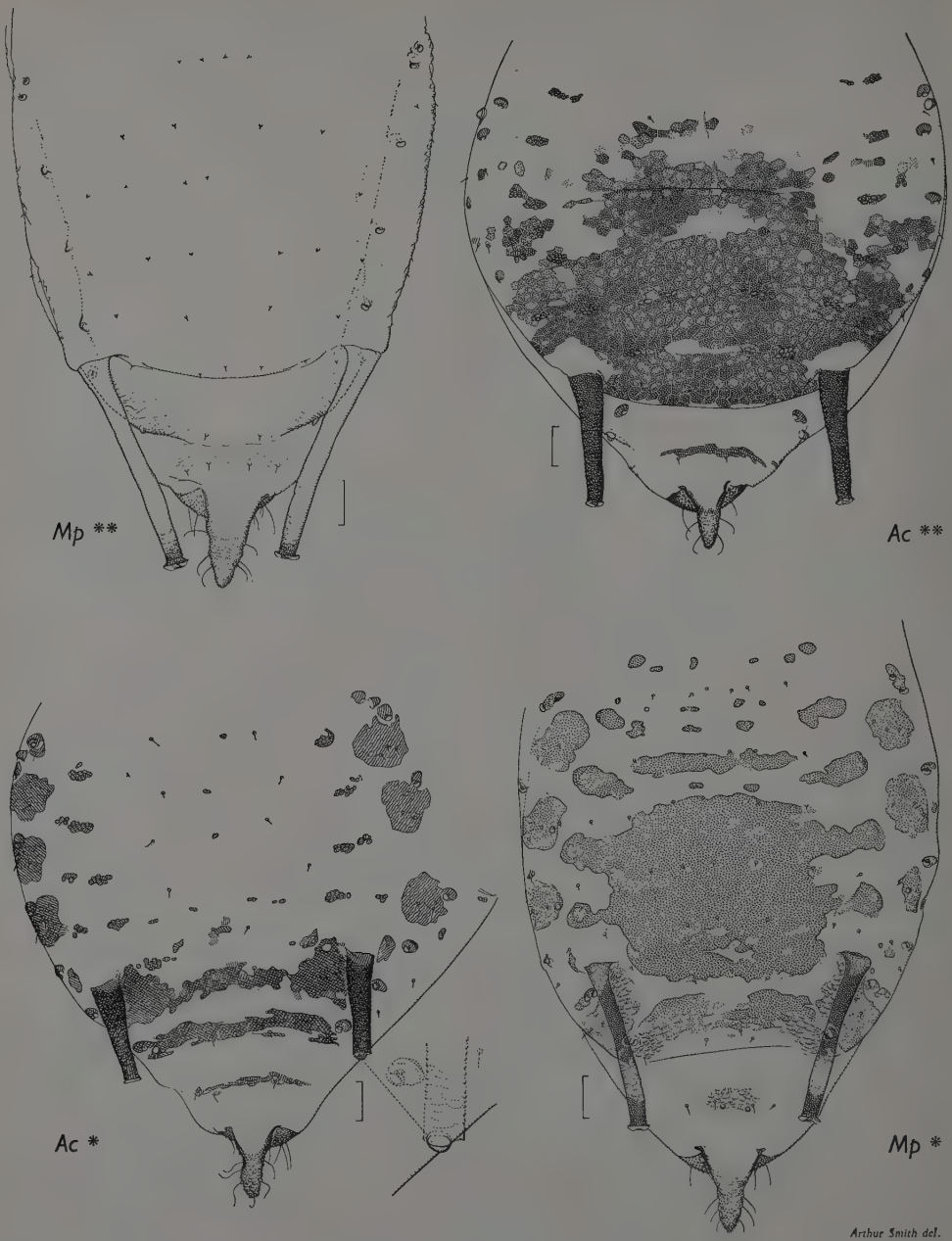


Figure 11. The diagnostically important structures of the alate (*) and apterous (**) viviparous females of species of aphids living on *Citrus*, showing abdomina.

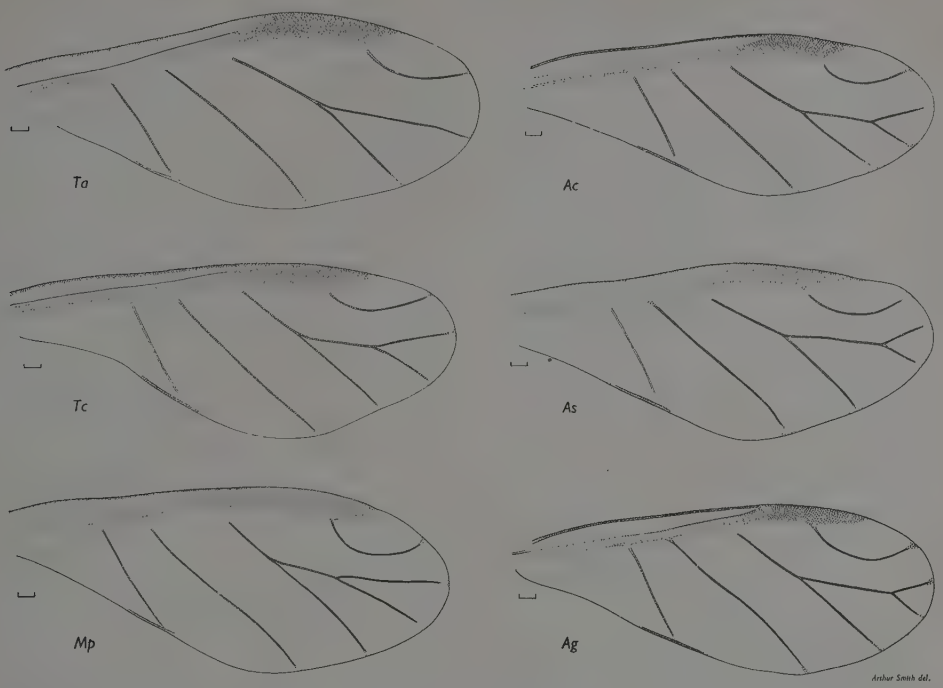


Figure 12. The diagnostically important structures of the alate (*) viviparous females of species of aphids living on *Citrus*, showing forewings.

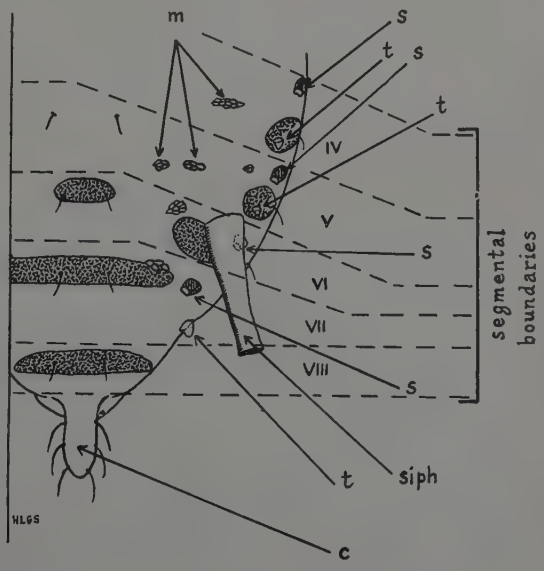


Figure 13. Key diagram of posterior segments of abdomen of apterous viviparous female of genus *Aphis* L., showing approximate segmental boundaries and relative positions of structures referred to in the key and descriptions of species. *c* = cauda ; *m* = intersegmental muscle sclerites ; *s* = spiracles ; siph = siphunculus (cornicle) ; *t* = marginal tubercles.

Notes on individual species

Macrosiphum euphorbiae (Thomas)

This species has been recorded on *Citrus* in North America, and may possibly be found casually on this host in the Mediterranean area. It is so polyphagous that its host range cannot be defined with any accuracy. It is a rather elongate, spindle-shaped aphid, varying in size from about 2 to 4 mm. long, the mean size being about 3 mm. Antennae long, varying from just less than to considerably more than as long as the body. Legs, siphunculi and cauda also long (see biometric data), the latter bearing typically 8 to 12 hairs. Antennal segment III in apterae with 1 to 8 secondary rhinaria toward base of segment (very rarely a single antenna may be without any); in alatae the same segment bears 9 to 21 rhinaria.

For fuller descriptions, reference may be made to Hille Ris Lambers (7), Cottier (5).

Biometric data for single specimens: *Aptera* — body 2.21 mm., antenna 2.88 mm., ratios of segments III-VI 78: 58: 53: 18 + 100, siphunculus 0.68 mm., cauda 0.36 mm., caudal hairs 9, secondary rhinaria on III 4 and 3, hind femur (without trochanter) 0.91 mm., hind tibia 1.75 mm. *Alata* — body 2.50 mm., antenna 3.25 mm., ratios of segments III-VI 78 : 73 : 62 : 19 + 114, siphunculus 0.68 mm., cauda 0.32 mm., caudal hairs 10, secondary rhinaria on III 17 and 18, hind femur (without trochanter) 0.98 mm., hind tibia 2.04 mm.

Myzus (*Nectarosiphon*) *persicae* (Sulzer)

When on *Citrus* this very highly polyphagous aphid tends to live scattered among colonies of one or other of the *Toxoptera* or *Aphis* species, from which it can easily be distinguished by its dull unicolorous light to medium green color and pale, dark-tipped elongate siphunculi, which are normally carried in a convergent posture close to the postero-lateral margins of the abdomen. Under microscopic examination the siphunculi are slightly expanded on the apical half, though this character can be absent in spring migrants moving over from peach. The species is of not more than medium size, with maximum body length about 2.6 mm. Antennae in apterae a little shorter than body, pale basally, darkening gradually over apical third, segment III without any secondary rhinaria; in alatae up to a little longer than the body, uniformly darkish sclerotic, segment III with a row of about 6 to 17 secondary rhinaria along its length. Cauda with 5 to 8 hairs.

The literature on *Myzus persicae* is voluminous and scattered. Cottier (5) discusses morphological variation rather extensively, while Broadbent (4) has published good photographic figures illustrating differences between alatae produced on peach and on secondary hosts. Other papers are very largely relevant to the role of the species as a vector of potato viruses, and less so to the present discussion. There is as yet no evidence that the species is of importance on *Citrus*, though in view of its exceptional record of vector ability for other diseases the possibility cannot be altogether eliminated that some transmission of tristeza by *M. persicae* might take place.

Biometric data for single specimens: *Aptera* — body 2.17 mm., antenna 1.79 mm., ratios of segments III-VI 52 : 36 : 30 : 14 + 52, siphunculus 0.55 mm., cauda 0.23 mm., caudal hairs 6, hind femur (without trochanter) 0.63 mm., hind tibia 1.11 mm. *Alata* — body 2.11 mm., antenna 2.22 mm., ratios of segments III-VI 62 : 48 : 37 : 18 + 68, siphunculus 0.40 mm., cauda 0.30 mm., caudal hairs 6, secondary rhinaria on III 14 and 16, hind femur (without trochanter) 0.66 mm., hind tibia 1.32 mm.

Aphis gossypii Glover

The importance of this species as a pest of *Citrus* lies in its proven capacity, in at least one part of its range, to act as a somewhat inefficient vector of tristeza in *Citrus*. Its possible role in this respect in the Mediterranean area has not yet been fully investigated, but it occurs quite commonly on young shoots of *Citrus*, often mixed with *Toxoptera aurantii* and *Aphis craccivora*. It is not a very large species, not usually exceeding 2.1 mm. in length, and with mean length about 1.5 mm.

Antennae in both apterae and alatae much shorter than the body. Cauda with 4 to 7 hairs. Apterae are not hard to recognize in the field by their color and lack of shine; while microscopically they are equally distinct (see key). Alatae of *A. gossypii* and *A. craccivora* are by no means so easy to distinguish, particularly if small, lightly-marked specimens are involved; the firmest ground is offered by the relative lengths of the apical rostral segment and joint II of the hind tarsus.

Taxonomically, much confusion has existed about the identity of *A. gossypii*, which it is beyond the scope of this account to try and disentangle. Roberti (13) has placed *A. gossypii* among the synonyms of *Aphis frangulae* Koch, using *Rhamnus* species as primary hosts. Börner (2) regards *A. frangulae* as migrating only to *Eupatorium cannabinum*, and states that *A. gossypii* is a species with a purely viviparous cycle. Kring (8) claims to demonstrate a full cycle for *A. gossypii* in North America, the over-wintering host being *Catalpa* (Bignoniaceae). So far as the Mediterranean area is concerned there seems no good reason for separating the aphids occurring on *Citrus* from those living on the type host of *A. gossypii*, *Gossypium*. Further taxonomic studies are desirable, however, in view of the failure so far to demonstrate vector ability for tristeza in Mediterranean *A. gossypii*, and the possibility that North American *A. gossypii* on *Citrus* has a different cycle. Important papers dealing with morphology, variability and synonymy of *A. gossypii* are those of Paddock (9), Patch (10), Batchelder (1), Wall (15) and Cottier (5).

Biometric data for single specimens: *Aptera* — body 1.74 mm., antenna 0.98 mm., ratios of segments III-VI 24 : 18 : 18 : 12 + 27, siphunculus 0.26 mm., cauda 0.17 mm., caudal hairs 6, hind femur (without trochanter) 0.38 mm., hind tibia 0.67 mm. *Alata* — body 1.86 mm., antenna 1.38 mm., ratios of segments III-VI 36 : 28 : 26 : 16 + 36, siphunculus 0.26 mm., cauda 0.16 mm., caudal hairs 7, secondary rhinaria on III 13 and 13, hind femur (without trochanter) 0.51 mm., hind tibia 0.98 mm.

Aphis spiraecola Patch

This aphid, which is probably native to North America, has a life cycle in which the *Spiraea* species serve as overwintering hosts and *Citrus*, among very many other widely different plants, as a secondary host. It has been introduced, however, to other parts of the world where it would seem to be able to live permanently on secondary hosts. Up to now it is not known from areas of *Citrus* culture in the Mediterranean basin. In size *A. spiraecola* resembles *A. gossypii*, while morphologically it bears a close relationship to *Aphis pomi* de Geer, and is described under this name from *Pyrus* in New Zealand by Cottier (5) (V.F. Eastop *in litt.*).

On *Citrus*, *A. spiraecola* may be recognized by its lemon-yellow to apple-green color, dark tapering siphunculi and short antennae. For additional confirmation recourse should be had to the caudal hair number and femoral hair lengths (see key).

Biometric data of single specimens: *Aptera* — body 1.40 mm., antenna 0.82 mm., ratios of segments III-VI 20 : 14 : 14 : 10 + 23, siphunculus 0.22 mm., cauda 0.16 mm., caudal hairs 8, hind femur (without trochanter) 0.35 mm., hind tibia 0.68 mm. *Alata* — body 1.74 mm., antenna 1.00 mm., ratios of segments III-VI 25 : 20 : 18 : 11 + 27, siphunculus 0.22 mm., cauda 0.17 mm., caudal hairs 11, secondary rhinaria on III 8 and 8, on IV 2 and 3, hind femur (without trochanter) 0.44 mm., hind tibia 0.82 mm.

Aphis craccivora Koch

This species is predominantly a pest of leguminous plants, but also occurs quite commonly on *Citrus*, either by itself or in mixed colonies with *Aphis gossypii* and *Toxoptera aurantii*. Its size varies with the host on which it occurs; specimens from *Citrus* in my possession range from about 1.7 to 2.1 mm. long, while on some Leguminosae the size may be rather greater.

When mounted, apterae of *A. craccivora* are unmistakable because of the partly or wholly black abdominal dorsum. Alatae have a different arrangement of the abdominal markings,

which in lightly pigmented specimens is very similar to that of *A. gossypii*; but in typical examples the transverse sclerites on the individual tergites are much longer, particularly on the posterior segments, where they often extend across the whole width of the tergites and unite with the postsiphuncular and marginal sclerites. Alatae bear 3 to 8 secondary rhinaria on segment III of the antennae. The caudal hairs number 4 to 8 in apterae and alatae.

The synonymy of *craccivora* includes *laburni* auct. nec Kltb., *medicaginis* auct. nec Koch and *leguminosae* Theob. Réal (11) gives an account of its bionomics on groundnuts, and a good morphological account is given by Cottier (5).

Biometric data for single specimens: *Aptera* — body 2.00 mm., antenna 1.43 mm., ratios of segments III-VI 42 : 30 : 27 : 15 + 32, siphunculus 0.46 mm., cauda 0.21 mm., caudal hairs 6, hind femur (without trochanter) 0.63 mm., hind tibia 1.17 mm. *Alata* — body 1.98 mm., antenna 1.33 mm., ratios of segments III-VI 34 : 28 : 27 : 16 + 32, siphunculus 0.32 mm., cauda 0.19 mm., caudal hairs 7, secondary rhinaria on III 8 and 6, hind femur (without trochanter) 0.51 mm., hind tibia 1.01 mm.

Toxoptera aurantii (Boyer de Fonscolombe)

The best known of the Mediterranean *Citrus* aphids, also occurring commonly on a number of other hosts, such as tea, coffee and cacao, in regions where these are grown. Dense colonies are formed on the young foliage of *Citrus*, and these are peculiar in being able to produce an audible scraping sound. This is accompanied by a concerted movement of the individual aphids, consisting of a circular oscillation of the hind end of the body, which is believed to bring the characteristic sculptured stridulatory area on the sides of the abdomen into contact with the modified conical spines on the hind tibiae. The sound produced is not very apparent in the field, but if a colony is confined in a tin the resonating properties of the container make it quite audible if the ear is brought near the aphids while stridulating.

Toxoptera aurantii is a rather smaller aphid than its relative *T. citricidus*, though some overlap in size occurs around 1.8 mm. body length. Alatae of the two species are easily separated (see key), but microscopic examination is necessary to separate apterae, at least until the subtler aspects of facies are appreciated through experience. Immature forms of both *Toxoptera* species are warm brown in color, as against various shades of green, brownish green or greyish in the *Aphis* species on *Citrus*.

A more detailed description of *Toxoptera aurantii* is given by Cottier (5), and details of the bionomics of the species in Israel are given by Rivnay (12).

Biometric data for single specimens: *Aptera* — body 1.82 mm., antenna 1.72 mm., ratios of segments III-VI 45 : 34 : 35 : 12 + 52, siphunculus 0.26 mm., cauda 0.19 mm., caudal hairs 17, hind femur (without trochanter) 0.51 mm., hind tibia 1.04 mm. *Alata* — body 1.90 mm., antenna 1.63 mm., ratios of segments III-VI 38 : 36 : 33 : 12 + 49, siphunculus 0.24 mm., cauda 0.16 mm., caudal hairs 12, secondary rhinaria on III 6 and 6, hind femur (without trochanter) 0.50 mm., hind tibia 0.97 mm.

Toxoptera citricidus (Kirkaldy)

A rather sturdy and medium-sized shiny blackish aphid, in general resembling *Toxoptera aurantii* apart from its rather greater average size. Its habits on *Citrus* are similar, but its host range is more restricted than that of *T. aurantii*, and it rarely lives on plants outside the family Rutaceae. It is a fairly efficient vector of the virus of tristeza, and is widely distributed in the moist tropics, extending into the temperate zones in New Zealand, South Africa, South America and Australia. In the northern hemisphere it is not yet known reliably from the Mediterranean area or North America; however, it occurs in the Caribbean and all over Africa south of the Sahara where conditions permit, and there would seem to be a permanent danger of its becoming established in such areas as southern Spain, Morocco, Cyprus and Florida, and perhaps also in Israel and California.

Alatae of *T. citricidus* are easily identified with a pocket lens by the wholly black third antennal segment succeeded by a pale fourth. Apterae require microscopic examination to

detect the very long, fine and erect hairs on the legs and body margins. Colonies of *T. citricidus* perform stridulatory movements, but produce no sound audible to the human ear.

Cottier (5) gives a fuller description of *T. citricidus* (which he places in the genus *Aphis*) ; the bionomics are discussed by Symes (14) and Hall and Ford (6), the latter using the name *Aphis tavaresi* del Guercio, a synonym of *T. citricidus*.

Biometric data for single specimens : *Aptera* — body 2.28 mm., antenna 1.60 mm., ratios of segments III-VI 42 : 32 : 24 : 13 + 51, siphunculus 0.36 mm., cauda 0.32 mm., caudal hairs 45, hind femur (without trochanter) 0.66 mm., hind tibia 1.19 mm. *Alata* — body 2.09 mm., antenna 1.66 mm., ratios of segments III-VI 38 : 38 : 29 : 12 + 54, siphunculus 0.40 mm., cauda 0.22 mm., caudal hairs 31, secondary rhinaria on III 10 and 14, hind femur (without trochanter) 0.61 mm., hind tibia 1.23 mm.

Other aphids recorded on *Citrus*

In addition to the seven foregoing species, several others are recorded or described from *Citrus*. These include *Toxoptera odinae* (van der Goot), *Macrosiphoniella citricola* v.d.G., *Pterochloroides persicae* (Chol.) and *Aphis nerii* B. de F. The first two of these are known only from the Far East. *P. persicae* is a lachnid living on peaches and apricots, and it is unlikely to establish itself on plants other than Rosaceae. *A. nerii*, however, is recorded as having occurred a number of times on *Citrus* in the Mediterranean area. Morphologically it will run down in the key to the genus *Aphis*. It is a bright yellow species whose color and caudal hair number (8 to 19) distinguish it readily from *A. gossypii* and *A. craccivora*. From *A. spiraecola* it may be separated by the length and structure of the anterior hairs of the femora, which are normal with easily observed apices, and not more than $^3/_4$ as long as the least width of the femora; and by the ratio of the apical rostral segment to the second joint of the hind tarsus, which is about $1^1/_2 : 1$ in *A. nerii*, and less than $1^1/_4 : 1$ in *A. spiraecola*. A more extended description of *A. nerii* is given by Cottier (5). Its normal hosts are species of Asclepiadaceae and Apocynaceae.

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* The works listed are confined to those which will assist in the determination of *Citrus* aphids by amplifying the morphological details given in the foregoing pages or supplying particulars of the biology of the species.

PLANT QUARANTINE ANNOUNCEMENTS

EASTERN GERMANY

An Ordinance dated 1 August 1960 contains executive regulations for the Plant Protection Law of 25 November 1953 concerning the importation of plants.

Import and transit of plants, parts thereof and plant products are prohibited except through the customs house listed in the Ordinance and unless they are accompanied by a phytosanitary certificate and a certificate of origin.

Certification

Phytosanitary certificates should be issued within 20 days before shipment in prescribed form in German and in the language of the country of origin, indicating scientific names of the plants and specific requirements attested in the certificate. Consignments subdivided after leaving the country of origin may be accompanied each by a certified copy or photocopy of the certificate and a declaration on the division of consignments in prescribed form.

Whenever disinfection or disinfestation has been carried out, date and particulars of the treatment should be indicated in the certificate.

Imports requiring permit

Broadleaf trees and conifers, or parts thereof, forest tree seeds (including cones), and unsawn timber of broadleaf trees, may be imported only under permit of the Ministry of Agriculture, Food and Forestry.

Exemptions may be granted for plants, fruit trees and ornamental plants of Ericaceae under the conditions outlined in the following two sections. For other dicotyledonous woody plants permits are granted only exceptionally under condition that they have been thoroughly treated against pests and diseases in the country of origin.

Importation of conifers without earth balls and conifer twigs is not restricted if for non-commercial purposes or as presents.

Imports restricted

DICOTYLEDONOUS WOODY PLANTS

(*a*) Importation of dicotyledonous woody plants of all units (trees and shrubs), including seedlings and young trees and parts thereof (twigs, shoots, scions, cuttings), is prohibited from countries or places where the San José scale (*Quadraspidiotus perniciosus*) occurs: Albania, Algeria, Australia, Austria, Bulgaria, Canada, China, Czechoslovakia, France, Western Germany, Greece, Hawaii, Hungary, India, Iraq, Italy, Japan, Kashmir, Korea, Lebanon, Mexico, New Zealand, Portugal, Romania, South African countries, South American countries, Spain, Switzerland, Trieste, U.S.A., U.S.S.R., Yugoslavia.

(*b*) From countries where the San José scale is not known to occur, woody fruit trees (*Cydonia, Malus, Prunus, Pyrus, Ribes, Rubus*), strawberry plants (*Fragaria*) and rose plants (*Rosa*), with the exception of cut flowers, fruit and seeds, or parts thereof, may be imported, provided (*i*) they originate from a plantation free from virus diseases, potato wart (*Synchytrium endobioticum*), potato root eelworm (*Heterodera rostochiensis*) and where no grape vines have been grown during the last five years; (*ii*) they are not packed with other plants, whose importation is prohibited; (*iii*) upon inspection they are found free from San José scale, *Viteus vitifolii*, *Hyphantria cunea*, *Laspeyresia molesta* and visible tumors caused by *Agrobacterium tumefaciens*.

(*c*) Importation of grape vines for propagation, uprooted vine plants, vine woo d

cuttings and shoots, vine leaves, used vine poles and supporters, compost and mold from vineyards is prohibited. One-year old vine cuttings may be exempted from prohibition if they have been fumigated in the country of origin.

Fruit

(*a*) Importation of fresh fruit and fruit for processing (including berries of *Ribes*, citrus fruit, grapes, ripe and unripe nuts with green shells) from countries where the San José scale occurs is permitted only if they are not packed with plants, whose importation is prohibited and are found to be free from San José scale, *Viteus vitifolii, Hyphantria cunea, Laspeyresia molesta, Rhagoletis pomonella* and *Ceratitis capitata*. Fruits attacked by *Rhagoletis cerasi* may be imported only under certain conditions.

(*b*) Tropical fruit (such as banana, pineapples, but excluding citrus fruit), fresh fruit carried by travelers up to 2.5 kg., and frozen fresh fruit, may be imported without restrictions.

Ornamental plants

Living ornamental plants, and parts thereof, may be imported from any country if they originate from a plantation free from virus diseases, potato wart and potato root eelworm, and where no grape vine was grown during the last 5 years. The following plants are subject to additional specific requirements.

(*a*) Azalea (*Rhododendron*) must be free from pests mentioned under dicotyledonous woody plants also from *Gracilaria azaleella, Acalla schalleriana, Septoria azaleae, Exobasidium japonicum*, and *Ovulinia azaleae*.

(*b*) Flower bulbs and tubers must be free from *Lampetia claviceps, L. equestris, Eumerus* sp., *Ditylenchus dipsaci, Taeniothrips simplex, Botrytis* sp., *Sclerotinia bulborum, S. gladioli, Sclerotium tuliparum, Xanthomonas hyacinthi, Fusarium oxysporum* f. *gladioli, Septoria gladioli*.

(*c*) Begonias free from *Xanthomonas begoniae*.

(*d*) Narcissus bulbs free from *Fusarium bulbigenum*.

(*e*) Chrysanthemums free from *Diarthronomyia chrysanthemi*.

(*f*) Potted plants free from *Popillia japonica*.

Importation of carnation plants and cuttings is prohibited and cut carnations may not be imported from 15 March to 15 November. For the rest of the year cut carnations may be imported if free from *Tortrix pronubana*. Cut carnations carried by travelers or used as decoration of vehicles are not restricted.

Potatoes

Importation of potatoes for whatever purpose is permitted only if:

(*a*) the growing and loading places are at least 2 kilometers from the nearest focus of potato wart;

(*b*) the holding is free from potato root eelworm;

(*c*) the consignment does not contain more than 2 percent by weight of soil;

(*d*) they are packed in new containers or when transported in bulk placed in a compartment officially sealed in the country of origin;

(*e*) they are not packed with other plants whose importation is prohibited;

(*f*) they are free from *Synchytrium endobioticum, Heterodera rostochiensis*, and *Phthorimaea operculella*;

(*g*) seed potatoes are in addition free from *Spongospora subterranea* and *Corynebacterium sepedonicum*;

(*h*) they are used as provisions for inland navigation up to 30 kg. per person and are kept on board.

Grains and seeds

Consignment of cereals or pulses infested with pests mentioned below may be required to be fumigated or processed under supervision. Exemptions may be accorded if the consignment is only lightly infested and appears to be harmless under the circumstances.

(*a*) Grains (*Avena, Hordeum, Panicum, Secale, Setaria, Sorghum, Triticum* and *Zea*) may be imported if the consignment is free from *Calandra granaria, C. oryzae, C. zeamais, Laemophloeus* sp., *Oryzaephilus surinamensis, Rhizopertha dominica, Sitotroga cerealella, Tenebroides mauritanicus, Trogoderma granarium.*

(*b*) Pulses (seed and fruit of *Cicer, Lathyrus, Lens, Lupinus, Phaseolus, Pisum, Soja, Vicia*) may be imported only if the consignment is free from pulse beetles (Bruchidae).

(*c*) Any kind of seed may be imported only if it is free from *Cuscuta* spp. and *Orobanche* spp. Lucerne and clover seed must, in addition, be free from *Bruchophagus funebris.* A certificate from the seed inspection service to this effect is required.

Imports unrestricted

1. Wreaths, including fir cones, cut flowers and bouquets.
2. Herbs and raw medicinal materials and raw material for industrial processing.
3. Living and dead plants, and parts thereof, imported for scientific or breeding purposes and addressed to research institutes.
4. Parcels up to 5 kg. for personal use by the consignee (except parcels, including postal packets, containing material for planting or breeding).
5. Seed samples for identification.

General provisions

1. Consignments, composed of various groups of plants, are subject to the strictest requirements applied to one of the groups.
2. Transit shipments under customs seal are not subject to these regulations unless infestation or infection is suspected.
3. The Ministry of Agriculture may grant exemptions to the regulations.

Prohibited pests, diseases and weeds:

Quadraspidiotus perniciosus
Viteus vitifolii
Hyphantria cunea
Laspeyresia molesta
Rhagoletis pomonella
Ceratitis capitata
Gracilaria azaleella
Acalla schalleriana
Lampetia clavipes, L. equestris
Eumerus sp.
Ditylenchus dipsaci
Taeniothrips simplex
Popillia japonica
Tortrix pronubana
Diarthronomyia chrysanthemi
Phthorimaea operculella
Heterodera rostochiensis
Bruchophagus funebris
Endoconidiophora fagacearum
Endothia parasitica
Agrobacterium tumefaciens
Septoria azaleae
Exobasidium japonicum
Botrytis sp.
Sclerotinia bulborum, S. gladioli
Sclerotium tuliparum
Ovulinia azaleae
Fusarium oxysporum f. *gladioli*
F. bulbigenum
Septoria gladioli
Xanthomonas begoniae, X. hyacinthi
Synchytrium endobioticum
Spongospora subterranea
Corynebacterium sepedonicum
Fruit tree viruses
Strawberry viruses
Grapevine viruses
Cuscuta spp.
Orobanche spp.

Pests permitted under certain conditions:

Rhagoletis cerasi
Calandra granaria, C. oryzae, C. zea-mais
Laemophloeus sp.
Oryzaephilus surinamensis
Rhizopertha dominica
Sitotroga cerealella
Tenebroides mauritanicus
Trogoderma granarium
Bruchidae

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IMPORTANT NOTICE

In order to make each volume coincide with the calendar year and to overcome the difficulty of accommodating longer articles in a monthly periodical of the present size, the *FAO Plant Protection Bulletin* is now published bimonthly in 1961, Volume 9 covering the period from October 1960 to December 1961 in nine numbers, as follows :

Volume 9, No. 1 - October 1960
" 2 - November 1960
" 3 - December 1960
" 4 - February 1961
" 5 - April 1961
" 6 - June 1961
" 7 - August 1961
" 8 - October 1961
" 9 - December 1961

To facilitate the speedy exchange of information, advance reports concerning outbreaks and the spread of important plant pests and diseases, as well as plant quarantine announcements, will be issued in mimeographed form and sent to the national plant protection services of countries concerned before publication in the Bulletin.

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